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(54) A FORMWORK FOR USE IN CASTING A CONCRETE STRUCTURE

(71) We, AB BYGGFORBATTRING, of Ljusstoparbacken 20 117 45 Stockholm, Sweden, a Swedish Joint-Stock Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a sliding or climbing formwork for use in casting a concrete structure which varies in cross-section along a substantially vertical major axis.

Technical, economic and practical problems occur in the use of formwork for the erection of relatively high concrete structures, such as chimney stacks, television towers, observation towers, pillars of bridges, cooling towers and the like, in which the horizontal cross-section of the structure varies in the direction of its height. In so-called climbing formwork the concreting is carried out in stages within stationary shuttering of predetermined height; when the concrete has set, the formwork is raised for the next casting stage by a distance corresponding to the height of the formwork. In so-called sliding formwork the concreting is performed continuously within the formwork which can move of slide upwards. Whichever of these methods is used, after the formwork has been moved upwards, the cross-section of the formwork must be adjusted in to the variation in the horizontal cross-section of the structure. The corresponding reduction or extension of the horizontal size of the formwork is a direct function of the geometrical design of the structure.

Not only must the formwork surface — i.e. the shuttering be extensible, but the securing system, by which the formwork walls are secured and which represents an integral part of the formwork system, and which supports the concrete, must be correspondingly extensible so that the concrete structure will have the required shape over its entire height. For practical and economical reasons the whole formwork construction — i.e., the formwork walls and the securing system — must be designed as one unit, supported at the base of the building, and thereafter used in cooperation for continuous concreting up to the top of the structure, without repeated dismantling and assembly. The only adjustments and re-adjustments of the formwork which are inevitable are those resulting from the gradual change in the horizontal cross-section of the structure in the upward direction.

With both climbing and sliding formwork, a number of generally similar methods of constructing the actual formwork walls are known. With circular cross-sections, or other closed, continuously curved cross-sections, these methods are generally based on so-called overlapping formwork — i.e., a part of the formwork so overlaps via a thin sheet of metal, an adjacent part of the formwork, that as the horizontal cross-section of the concrete construction decreases the distance of overlap gradually increases, and *vice versa*. With square, rectangular or polygonal cross-section structures, the formwork parts are arranged to slide past one another at an angle at the corners of the cross-section, as the horizontal cross-section of the structure changes.

Since the formwork walls are relatively thin, — about 3mm in sheet metal formwork and about 30 mm in timber formwork — the walls are readily deformable to correspond to the required curvature of a concrete surface with, for example, a circular cross-section.

In contrast, the difficulty of achieving satisfactory adjustment of the securing system receiving the pressure of the concrete behind the formork walls, and therefore also the pressure-receiving locking or yoke construction between the two side walls of the formwork is much greater. It is necessary to take into account not only this basically horizontal loading by the pressure of the concrete, but also the vertical loading by the formwork, the loading of the securing system itself, and, in the case of sliding formwork, also the loading produced by the friction between the formwork and the concrete. The whole formwork support-

ing and shaping construction is subjected to both horizontal and vertical forces, and must therefore be constructed in the form of a three dimensional lattice. The lattice must have sufficient rigidity to prevent undesired deformation of the structure from the required shape of the concrete structure while at the same time the lattice must also in practice be readily adjustable. These demands apply in general to both climbing and sliding formwork. However, there is a certain difference between these two different types of formwork.

Climbing formwork needs a relatively small number of readjustments. In contrast, with sliding formwork the readjustments are continuously repeated, but as a rule they are very small. For erecting concrete structures of the kind mentioned above, therefore, it is necessary to provide a continuously extensible three-dimensional lattice which is at the same time rigid against unwanted deformation and is constantly located in all directions.

For the avoidance of pollution there is now an increased demand for chimney stacks of 300 m and more in height. Chimney stacks of this kind are generally constructed from concrete and have an upwardly tapering cross-section. For economic reasons, it is necessary to use in the construction of such structures only climbing or sliding formwork the latter being now preferred for technical and practical as well as economic reasons. Securing systems are known which comprise a three-dimensional lattice comprising frame members and diagonal strutting, the extensibility of such lattices being achieved on the one hand by making all the nodal points of the frame members and diagonal struts pivotable, and on the other hand by enabling the frame members and diagonal struts to be shortened or lengthened by means such as screwed connections. A three-dimensional lattice constructed in this way has a very large number of connections, (for example hundreds of connections) which must be adjusted to extend or construct the lattice. For example in continuous sliding formwork casting, the lattice must be so adjusted that the sliding formwork is continuously given a horizontal component of movement synchronised with the vertical component of movement, to obtain coincidence with the required generatrix in each vertical plane through the concrete structure. Since the axes of all these screwed connections are adjusted in different directions, it is impossible to operate some or all of them centrally from a central station and in synchronism without the use of undesirably complicated equipment. Such known systems are therefore, manually operated.

Accordingly the present invention provides a sliding or climbing formwork for use in casting a concrete structure which varies in cross-section along a substantially vertical major axis, the formwork comprising spaced formwork walls which constitute shuttering for the formation of the structure and which are movable to adjust the cross-section of the formwork to the required horizontal cross-section of the structure at different levels along said major axis, and a plurality of units each comprising two rods of equal length pivotally connected together at their centres by substantially horizontal shafts, or each comprising two rigid rectangular frames of equal size constructed from rods and being pivotally connected together along a common substantially horizontal central axis, said units being interconnected to form a framework which is connected to the formwork walls and which is adjustable by pivotal movement of the rods about their shafts or of the frames about their central axes, as the case may be, to adjust said cross-section of the formwork.

The invention will now be described in greater detail, by way of example, with reference to the accompanying drawings in which:

Figures 1 to 21 are diagrams illustrating the principles from which the invention proceeds;

Figure 22 is a perspective view illustrating a formwork according to a first embodiment of the invention;

Figure 23 is a perspective view illustrating a formwork according to a second embodiment of the invention;

Figures 24 to 29 and Figures 34 and 35 are diagrams illustrating a formwork securing system of a formwork according to a third embodiment of the invention;

Figure 30 is a perspective view of part of the securing system of Figures 24 to 29 and 34 and 35;

Figures 31 to 33 are diagrams illustrating the operation of the part shown in Figure 30; and

Figure 36 is a perspective view of a formwork according to a fourth embodiment of the invention.

The invention proceeds from the geometrical relationship between rods, illustrated in Figure 3. Two straight rods A1-B2 and A2-B1 of equal length are pivotably connected at centre 0, so that lines A1-B1 and A2-B2 each connecting one end of one of the rods to the other end of the other rod, extend parallel to one another in all angular positions of the rods. When a number of identical "scissors" rod arrangements as shown in Figure 3 are pivotably connected to one another (Figure 4), therefore, all the lines A1-B1 etc. are parallel with one another. Any change in length of one of the lines A1-B1 etc. causes a corres-

ponding change in the length of the other lines, thus maintaining the parallelism of the lines as illustrated for example in Figure 5. If, as shown in Figures 6 and 7 additional rods A1-C1 and so on are introduced into the system and sliding connections are provided at the points B1 to B6, the rods A1-C1 and so on always remain parallel with one another in all angular positions of the remaining rods. The arrangements of rods shown in Figures 7 and 6 thus in each case form a framework lying in a single plane and comprising a series of interconnected "scissors"-like sub-arrangements of rods.

If, in such a framework, the additional rods A1-C1, AC-C2 and so on are pivotally connected to addition scissors-like sub-arrangements of rods D1-F1, D1-B1, D2-F2, D2-B2 and so on, such sub-arrangements extending in planes perpendicular to the said single plane and there being sliding connections at points E1 etc. (Figures 8 and 9), between the rods D1-F1 and A1-E1 etc., the rods D1-F1, D2-F2 etc. will always extend parallel with the rods A1-C1 etc. Since the points B1 etc. are common, the rods will move in parallel in complete synchronism. If the distances A1-A2, A2-A3 etc. are equal to the distance D1-D2, D2-D3 etc., the composite framework first described is a three dimensional rectilinear one. If, however said distances are unequal the composite framework is of generally arcuate shape as shown diagrammatically in Figure 10, in which A1 - A2 = A2 - A3 etc., and D1-D2=D2-D3 etc. and D1-D2>A1-A2. In any given angular position of the rods, therefore, the framework may be said to consist of identical subframeworks A1-A2-B2-B1-E1-E2-D2-D1, etc. By changing the effective vertical length of one or more of the rods A1-C1 etc., the mutual positions of all the rods can be adjusted in a definite given geometrical relationship.

Figure 11 shows the two sub-frameworks disposed at an angle with respect to common vertical rods A1-C1 and A2-C2, each sub-framework having separate sliding connections at points B1 and B2; G1 and G2. The rods D1-F1 and D2-F2 have sliding connections at points H1 and H2 respectively. Parallel movement of the rods D1-F1 and D2-F2 in the direction of the rods A1-C1 and A2-C2 can therefore take place without mutual parallel movement of the last-mentioned rods, as shown in Figure 12. In the same way, the rods A1-C1 and A2-C2 can be moved mutually in parallel, without the rods D1-F1 and D2-F2 moving in the direction of the rods A1-C1 and A2-C2.

Figures 13 and 14 are diagrammatic plan views of two polygonal securing systems for locally fixing formwork for concrete casting, constructed from rods on the principles disclosed above. The operation of these securing systems will be described in geometrical terms; for example the rods will be referred to simply as lines. In both cases, for clarity's sake it has been assumed that the external outline A-A... of the locking system is to be reduced to the size A^1-A^1... Moreover, Figures 13 and 14 each show two lateral elevations explaining the geometrical events which occur during the reduction in size of the securing system. The internal outline D-D... of the system remains constant in both cases, this being indicated in the interest of clarity by shading along the line D-H. The reference letters used are basically analogous to those used above. The rods and nodal points correspond to those in Figures 11 and 12.

Figures 15—18 show diagrammatically how the line A-G of the geometrical construction can be moved in parallel relationship in the direction of the axis of the construction. The internal radius of the construction is referenced r, and its external radius R. The horizontal projection of the extensible or flexible rectangle A-D-H-G has a maximum length a and a minimum length b in the radial direction. In the starting position (Figure 15) the vertical lines D-H are locally fixed with relation to the horizontal plane by virtue of the fact that the two annular closed polygons D-D... and H-H... have a predetermined and unalterable outline, as indicated by the shading along the line D-H. The internal radius is referenced $r1$, so that the length of the external radius $R \equiv r1+a$. The vertical plumb line A-G can now be moved in parallel by a distance (a-b), i.e. into the position shown in Figure 16, in which therefore the external radius $R^1=r1+b$. In these positions the vertical lines A-G are now fixed in place — i.e., the closed polygons A-A... and G-G... are locked in a particular configuration (in this case indicated by shading along the line A-G while the inner polygons D-D... and H-H... are unlocked. The vertical straight lines D-H can now be moved parallel by the distance a-b into their innermost positions (Figure 17). Here the straight lines D-H are again locked and the straight lines A-G unlocked, so that a condition is reached analogous to that shown in Figure 15. However, the internal radius has now been reduced to the value $r2$. The external radius is therefore $R^1=r2+a$ $(=r1+b)$. Now, in the manner already described, the vertical lines A-G can again be moved in parallel by the distance $(a$-$b)$ — i.e. into their positions shown in Figure 18 $(R^1=r2+b)$. The operation described above can then be repeated. In this way, therefore, the plumb lines A-G can be moved as required in parallel relationship in the direction of the central axis of the geometrical construction.

Figures 19 and 20 show diagrammatically how, with the aid of the above described geometrical construction A-D-H-G, a rigid yoke 1 with formwork walls 2 has been disposed on the plumb line A-G, the walls being borne via adjustable supporting elements 3 by the yoke, and being adjustable by means of the supporting elements 3 to any inclination as indicated by the line I-I. The lifting force required to move all the structural components of the construction along the line I-I is provided by means of jacks 4 of known construction.

A securing system constructed as described above can be flexed as required, by forces acting exclusively parallel with one another, to change the lengths of the vertical rods which extend through the nodal points A and D, the forces for changing the lengths of the rods can be applied either as compressive forces between points A and G, and D and H, the vertical rods being moved in parallel relationship towards one another or the forces may be applied as tensile forces, the rods being moved in parallel relationship away from one another. Since all the forces and directions of adjustment are parallel (and in the examples described vertical), the means for producing these forces and movements of nodal points can readily be simplified, standardised and synchronised and the required movements of the mobile articulation points can be performed with great accuracy. Continuous or intermittent changes in dimensions of the securing system can be performed from a single, central control station.

With a given step-wise movement indicated at Δz in Figure 21, which is usually constant (in a concreting operation in which a sliding formwork is employed) along any line of inclination I-I (Figures 19 and 20), the walls 2 and the yoke 1 — i.e. the point A must be moved by a distance Δx in the horizontal direction, the distance Δx depending on the inclination of the line I-I, which in turn depends upon the relative dimensions of Δz and Δy. To produce this horizontal movement by the distance Δx, the radius R must be reduced by a corresponding distance a-b, this reduction in diameter being produced by increasing the distance A-G. The distance Δz along the line of inclination I-I corresponds to a climbing step of the means for lifting the sliding formwork along its climbing rod which is disposed on the line I-I. With lifting means, each climbing step is usually of about 25 mm in height. The required horizontal movement depends on the height of the climbing step, and the inclination of the line I-I. The increase in the distance A-G required in the present case also depends on the lengths of the lines A-H and D-G (which are of equal length), and also on the angles defined by these lines during the lifting of the formwork. The change in the distance A-G required for each lifting step can therefore be predetermined geometically and mathematically for each different height of the sliding formwork during the step-wise lifting operation.

Figure 22 shows a practical embodiment of sliding formwork having a securing system for securing the sliding formwork in position in the casting of a concrete structure having a cross-section which varies along a substantially vertical major axis, the whole securing system being disposed within the sliding formwork. The sliding formwork has yokes 1, walls 2, supporting elements 3 between the formwork and each yoke, lifting members in the form of jacks 4 and climbing rods 4*a* for the jacks 4. In the securing system, uprights 5 connected to the yokes 1 each have a fixed part 5*a*, and a movable part 5*b*. Scissors-like sub-arrangements of rods 6 are generally radially directed and are connected each to an upright 5*a*, 5*b*, pivotally at 6*a* and 6*b*. The inwardly and upwardly directed rod 6 is pivotably connected at 6*c* an upright 7, the inwardly and downwardly directed rod 6 being attached to the upright 7 via a retaining member 6*d* slidable along the lower portion of the upright. The sub-arrangements of rods 8 extending generally tangentially of the sliding formwork are attached at their upper ends via pivots 8*a* to the uprights 7, and at their lower ends are each slidably and pivotally connected to the lower part of the upright via a retaining member 8*b*. The upper ends of the uprights 7 are interconnected by rods 9 which are all of identical length in the symmetrical construction shown. Conveniently, the rods 9 are of adjustable length, being formed of relatively slidable parts which can be locked. A device 10 for example, a pressurised screw apparatus, is provided for changing the length of each upright 5*a*, 5*b*. The uprights 5*a* 5*b* must be lengthened as the cross-section of the concrete construction is reduced.

During casting with the aid of sliding formwork each "scissors" unit comprising parts 7—9 is locked in a geometrically fixed position at its retaining member 8*b*. The "scissors" unit comprising parts 5—7, to which the yoke 1 with its formwork 2 is attached, can be so extended by actuating its apparatus 10 that the yoke, and therefore the formwork, moves in the radial direction — for example, inwardly —, that is to say, the horizontal cross-section of the concrete decreases. When the upright 5*a*, 5*b* has moved in the direction of the upright 7 and parallel thereto by the greatest possible distance, the unit 7—9 is adjusted. First, the relatively slidable parts of the rod 9 and

the two sliding retaining members 8*b* are unlocked. The apparatus 10 is operated in the opposite direction to that in which it was previously operated so that the upright 7 is moved in each case radially inwards opposite to the parallel to the upright 5*a*, 5*b* by the rod 6 and the shortening of the upright 5*a*, 5*b*. The uprights 7 are thus moved parallel to one another by the rods 8, the retaining members 8*b* of the latter being in this case slid downwards. When the upright 7 has been moved as far inwards as posible (during which movement the upright 5*a*, 5*b* remains stationary), the retaining member 8*b* is again locked to the upright 7. Thereafter the casting can be continued as before.

Figure 23 shows another practical embodiment of a formwork having a securing system for the same purpose as the system of Figure 22 but which is disposed entirely outside the sliding formwork. The references used in Figure 23 and also the basic operation of the securing system, are analogous to those of Figure 22. When the cross-section of the concrete construction decreases, the uprights 5*a*, 5*b* must be shortened.

The securing system can be simplified, by using instead of two systems of subarrangements of rods in the form of "scissors" units for example according to Figure 13 (the tangential units A-A and the radial units A-D, each comprising two rods), two rigid rectangular frames of equal size constructed from rods and being pivotally connected together along a central substantially horizontal axis. Figure 24 shows diagrammatically two frames comprising members A3-D3-H4-B4 and A4-D4-H3-B3 which are relatively rotatable about a common centre axis 0-0. These frames will be referred to hereinafter as "primary frames". When the two primary frames are rotated about the axis 0-0 the members A3-D3-H3-B3 and A4-D4-H4-B4 are moved in parallel relationship with respect to one another. A number of such extensible units can be disposed closely adjacent one another and at an angle in relation to one another with their axes 0-0 of rotation horizontal (as shown in Figure 25), and intersecting at a common centre 0. If the distances between the points A2, A3, etc. and B2, B3 etc. are equal and at the same time the points D2 and D3 etc. and H2 and H3 etc. are made to coincide in pairs, and the resulting surfaces A2-A3-B3-B2 etc. are fixed there is provided a three dimensional geometrical system having nodal points whose positions are determined. The same also applies if the points D2 and D3 etc. and H2 and H3 etc. do not coincide, as long as the surfaces D2-D3-H3-H2 etc. and the surfaces A2-A3-D3-D2 etc. are fixed.

The geometrical system shown in Figure 25 is therefore made up of a number of units A3-A4-D4-D3-B3-B4-H4-H3. all having extensible surfaces parallel in relation to one another, and a number of rigid. fixed length secondary frames A2-A3-D3-D2-B2-B3-H3-H2 (shown in broken lines in Figure 24).

If all the primary frames perpendicular to the axes 0-0 of rotation have a given length and the axes are horizontally orientated (Figure 25), then for each equal change in length (in this case change in height) of the secondary frames. the horizontal projection of the system will also change in a given geometrical manner. As shown in Figures 26 and 27, in plan view, rotation of the primary frames about their axes of rotation 0-0 to increase the height of each unit, causes the internal radius *r* and the external radius R to be shortened, the radial width *a* of the units remaining constant.

Figures 28 and 29 show diagrammatically in vertical section and in perspective a basically horizontal substantially circular (in practice polygonal) system of the aforementioned units which narrows in the upward direction (only the units which are extensible in all planes are shown), the vertical section (the secondary frame) being indicated in its starting position (Figure 28) by the reference A-D-H-B. At a higher level as shown in Figure 29 the vertical section (the secondary frame) has assumed the form A¹-D¹-H¹-B¹. As indicated in Figures 28 and 29, the system can be employed to adjust the positions of formwork walls 2 carried by a sliding formwork rigid yoke 1 through adjustable supporting members 3 in a similar manner to that described above with reference to Figures 19 and 20, to take account of the variations in horizontal cross-section of a tapering concrete structure to be produced with the aid of the formwork.

Figure 30 shows diagrammatically and in principle how a sliding formwork yoke can be combined with the coupled secondary frames having members A2-D2-H2-B2 and A3-D3-H3-B3. The non-flexible yoke leg 1*c* is rigidly secured to a horizontal top yoke beam 1*a* and bottom yoke beam 1*b*. A displaceable yoke leg 1*e* can be secured at desired positions along the yoke beams 1*a* and 1*b*. A non-flexible upright 1*d* rigidly secured to the top and bottom yoke beams 1*a*, 1*b* co-operates with the yoke leg 1*c* and the yoke beams 1*a* and 1*b* to form a rigid frame. The rod B3-H3 of a first primary frame (shown in full in Figure 34) is pivotally connected to one end of each lower (as seen in Figure 30) secondary frame horizontal member, the corresponding rod of a second primary frame being connected to the other ends of said horizontal members. The rod A3-D3 of the first primary frame

is connected to one end of each of the upper (as seen in Figure 30) secondary frame horizontal member, the corresponding rod of the second primary frame being connected to the other ends of these horizontal members which extend from a structure 1*f* which is slidable along the uprights 1*c* and 1*d*. The angles defined by said rods B3-H3 and A3-D3 and their corresponding rods of the second primary frame can be adjusted by engaging the rods in selected holes in the horizontal members A2-A3 and B2-B3. The structure 1*f* is movable along the uprights 1*c* and 1*d* in the direction of the arrows P by screw apparatus 10 (mentioned above) to adjust the vertical dimensions of frames in accordance with the inclination of the wall to be concreted, the yoke being shifted rightwardly (as seen in Figure 30).

Figures 31—33 illustrate diagrammatically and on a reduced scale the appearance of the yoke when the adjustable yoke leg 1*e* has been locked in three respective positions to obtain three respective distances between the two sliding formwork walls 2 — corresponding to three different thicknesses of the concrete wall. Otherwise the references are identical with those used in Figures 19 and 20.

The maximum and minimum values of the angle A4-0-A3 (Figure 34) are in practice limited, so that for a given value of the distance A4-B3 (equal to the distance A3-B4), the periphery of the formwork and thus the diameter of the concrete wall can be reduced only by about one-half. However, frusto-conical concrete chimney stacks, for example, decrease in diameter by about one third, over their height. To allow for such a considerable taper without, for example, having to disconnect the secondary frames, the primary frames A3-D3-H4-B4 and A4-D4-H3-B3 etc. can be made of adjustable length perpendicularly to the axis of rotation 0-0. Figure 35 shows the primary frames reduced to new dimensions A3°-D3°-H4°-B4° and A4°-D4°-H3°-B3°. In construction the frame members A3-B3 and D3-H3, and A3-B4 and D3-H4 can, for example, be extensible and lockable in precisely determined positions thus ensuring precisely determined lengths for the members. In practice, when these members are unlocked the force indicated by the arrow P (Figure 30) is brought into operation in the opposite direction—i.e. the secondary frames in Figure 30 are reduced in height. Since the yokes are stationary the primary frames are synchronously and uniformly shortened and the frame members are again locked and the concreting operations continued.

Figure 36 shows a practical example of a formwork having a securing system mainly comprising flat rigid frames, for use in the construction of an upwardly tapering building for example a frusto-conical chimney stack. A stationary sliding formwork yoke has two yoke legs 1*c* connected by the yoke beams 1*a* and 1*b* to form a rigid frame. The formwork walls are referenced 2, their adjustable supports against the yoke 3, the jacks 4 and their climbing rods 4*a*. The intersecting, primary frames comprise frame rods (members) 15*a*, 15*b*, and are so constructed that opposite frame rods are parallel with one another, each individual frame being rendered rigid by means of corner reinforcements or diagonal rods. The rod 16 extends along the common axis of rotation corresponding to the axis 0-0 mentioned above. At the bottom, the frames are pivotably connected to the stationary bottom yoke beam 1*b*, and are pivotably connected at the top to a transverse beam 1*f* which is displaceable along the yoke legs 1*c* in both directions, under the action of one or two screw apparatus 10, of the kind described above. If the apparatus 10 are operated in the direction to move the transverse beam 1*f* upwardly the horizontal cross-section of the system is reduced, and *vice versa*. The operation of the apparatus 10 to reduce the cross-section is partly or completely synchronised with the lifting movement of the jacks 4 along the line of inclination of the wall of the chimney stack.

In the securing systems described above, the apparatus 10 may be arranged to be controlled from a common control station.

WHAT WE CLAIM IS:—

1. A sliding or climbing formwork for use in casting a concrete structure which varies in cross-section along a substantially vertical major axis, the formwork comprising spaced formwork walls which constitute shuttering for the formation of the structure and which are movable to adjust the cross-section of the formwork to the required horizontal cross-section of the structure at different levels along said major axis, and a plurality of units each comprising two rods of equal length pivotally connected together at their centres by substantially horizontal shafts, or each comprising two rigid rectangular frames of equal size constructed from rods and being pivotally connected together along a common central substantially horizontal axis, said units being interconnected to form a framework which is connected to the formwork walls and which is adjustable by pivotal movement of the rods about their shafts or of the frames about their central axes, as the case may be, to adjust said cross-section of the formwork.

2. A formwork as claimed in claim 1, in which rigid yokes carrying the formwork walls are interposed between adjacent units,

each yoke comprising two legs interconnected by transverse beams, the adjacent units being connected pivotally to one of the legs and to a holder slidable longitudinally of the other yoke leg or to an extension of such leg which is axially slidable with respect to the remainder of the leg, to allow said pivotal movement of the rods or frames of the adjacent units.

3. A formwork as claimed in claim 1, in which rigid yokes carrying the formwork walls are disposed between each pair of adjacent units, the yoke comprising two legs interconnected by transverse beams, one of which is movable axially of the yoke legs and to which the adjacent units are connected, these units also being pivotally connected to the other yoke leg, to allow said pivotal movement of the rods or frames of the adjacent units.

4. A formwork as claimed in claim 2, in which the said cross-section of the formwork is adjustable by altering the lengths only of parallel rods of framework to bring about the said pivotal movement.

5. A formwork as claimed in claim 2, 3 or 4, in which each yoke carries screw apparatus for bringing about the said pivotal movement of the rods or frames of the units connected to the yoke, the screw apparatus being controlled from a common control station to adjust said cross-section of the formwork.

6. A formwork as claimed in any one of the preceding claims, in which each unit comprises spaced uprights the spacing between which is adjustable by means of an extensible connection between the uprights.

7. A sliding or climbing formwork for use in casting a concrete structure which varies in cross-section along a substantially vertical major axis, substantially as hereinbefore described with reference to the accompanying drawings.

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Fig. 1

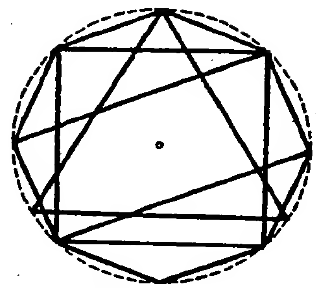
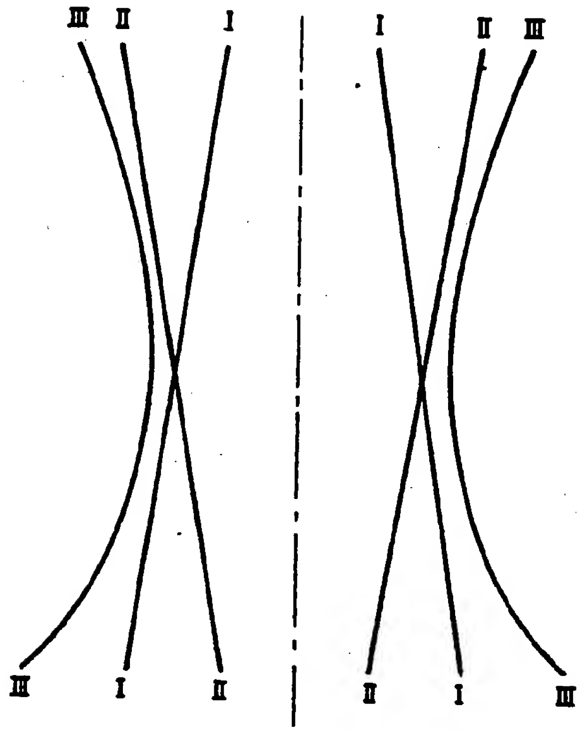


Fig. 2



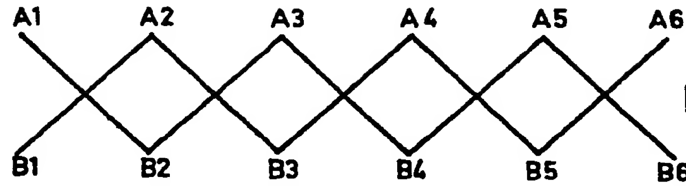


Fig. 4

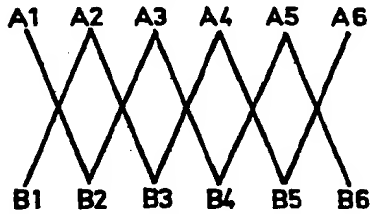


Fig. 5

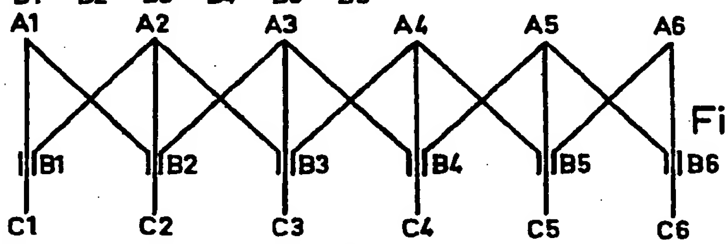


Fig. 6

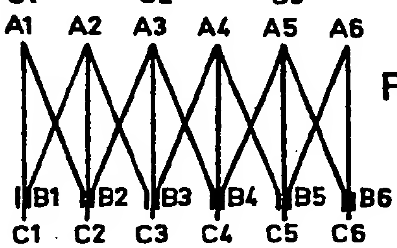


Fig. 7

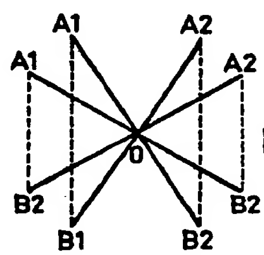
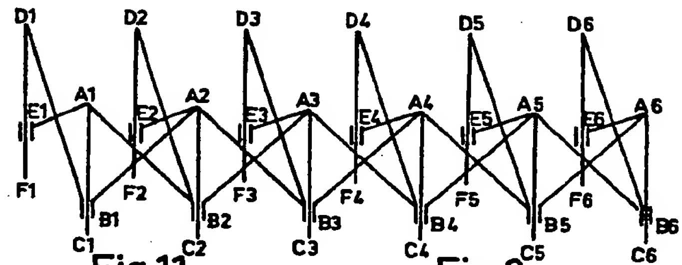


Fig. 3

Fig. 8



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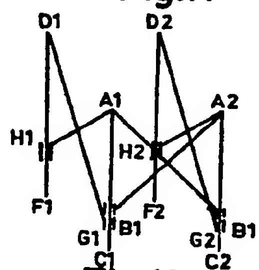

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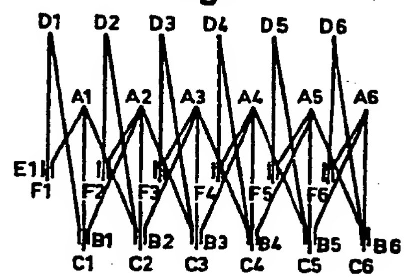

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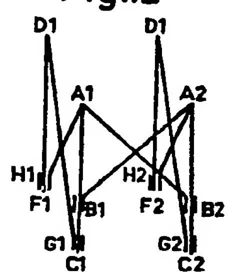


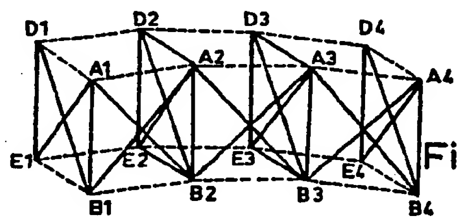


Fig.10

Fig. 13

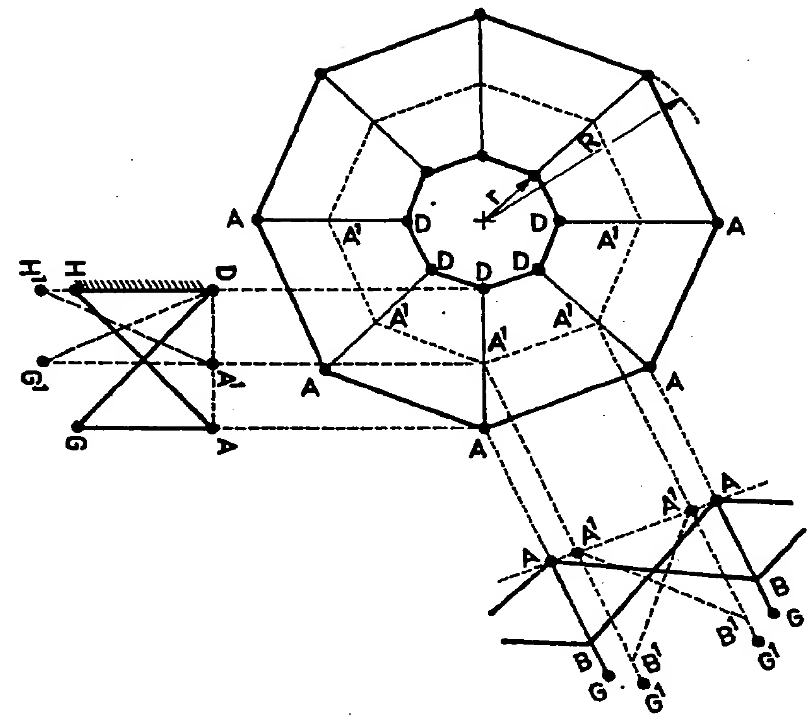
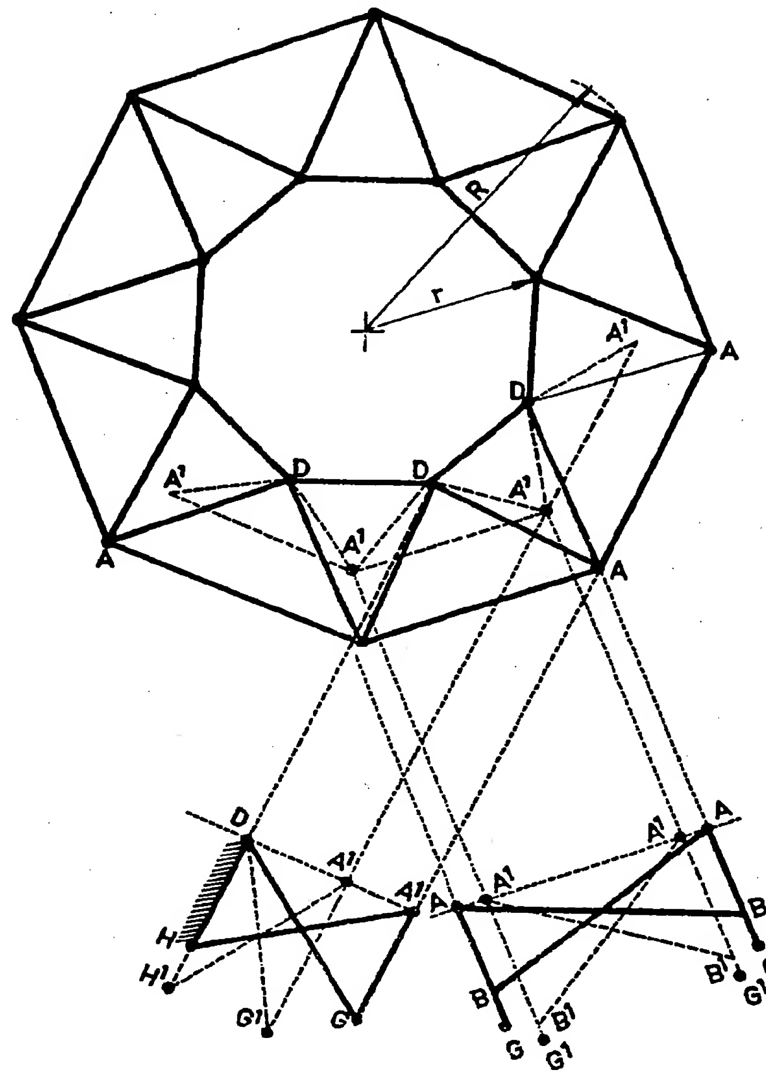


Fig.14



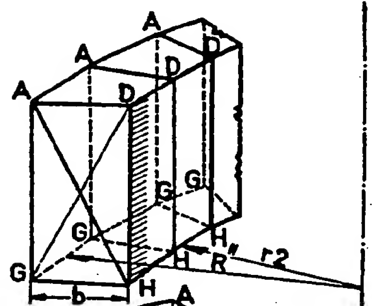


Fig. 18

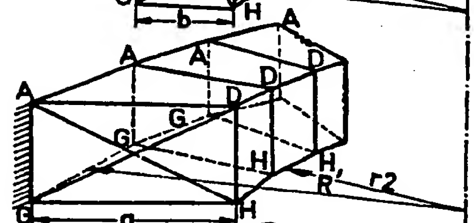


Fig .17

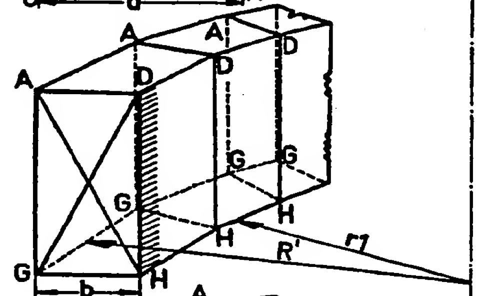


Fig.16

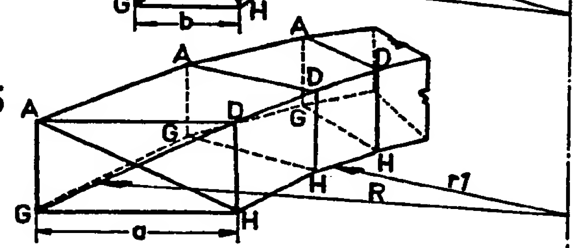


Fig.15

Fig. 20

Fig.21

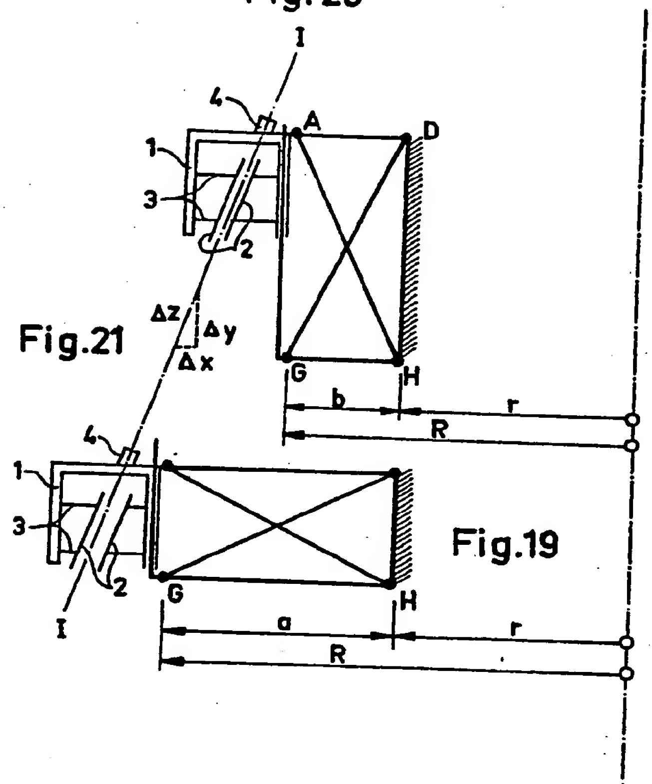


Fig.19

Fig. 22

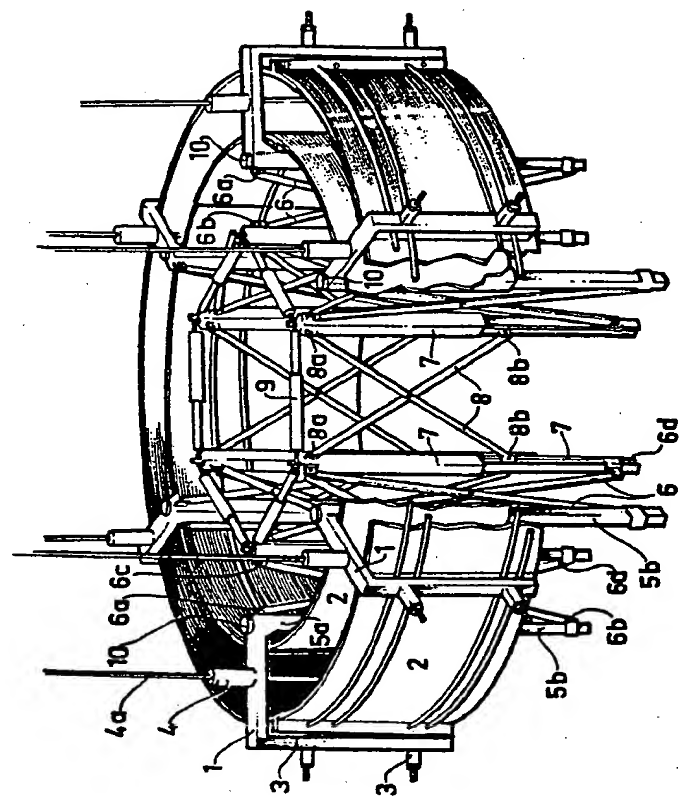


Fig.23

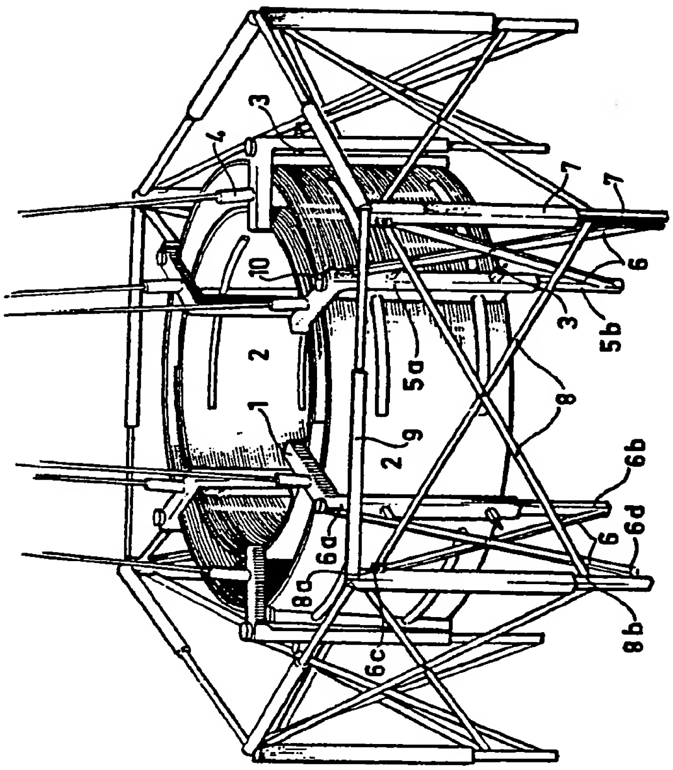
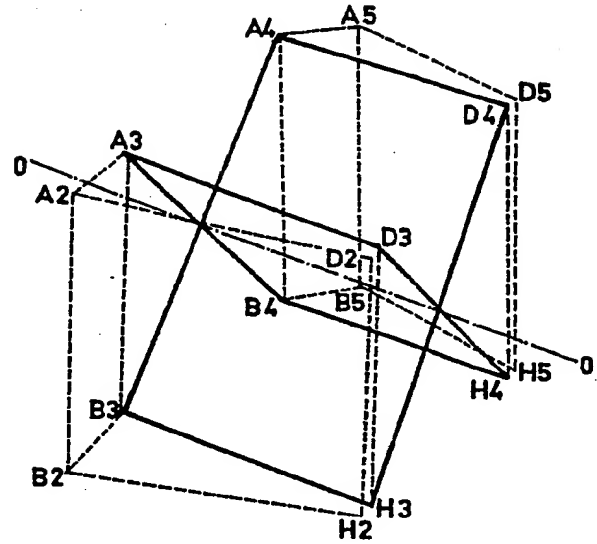


Fig. 24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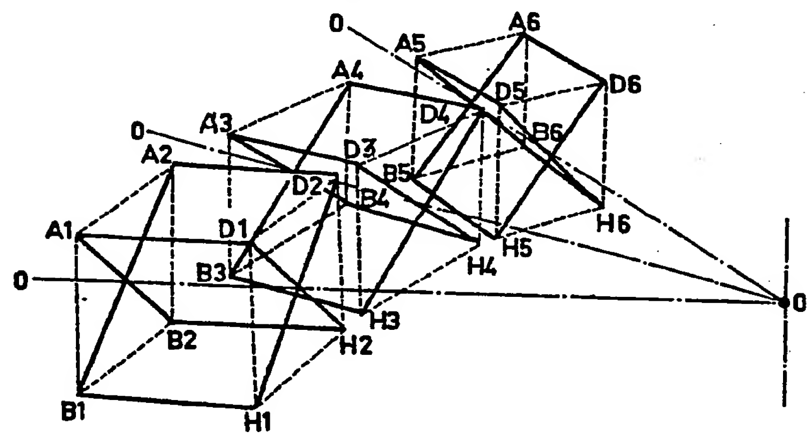
A5
D5
D4
A3
0
A2
D3
D2
B4
B5
H5
0
H4
B3
B2
H3
H2

Fig. 25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A5
A6
A4
D6
D5
D4
A3
0
B6
A2
D3
B5
D2
B4
H6
A1
D1
H5
B3
H4
0
0
H3
B2
H2
B1
H1

Fig. 27

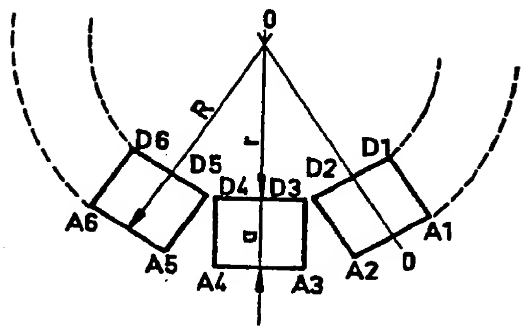

0
R
r
D6
D5
D4
D3
D2
D1
A6
A5
A4
A3
A2
A1
a
0

Fig. 26

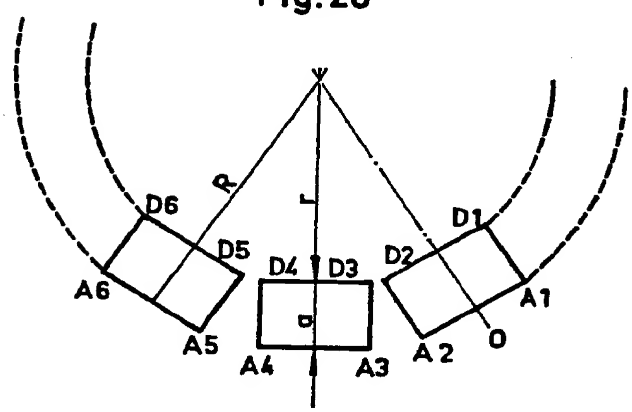

R
r
D6
D5
D4
D3
D2
D1
A6
A5
A4
A3
A 2
A1
a
0

Fig. 29

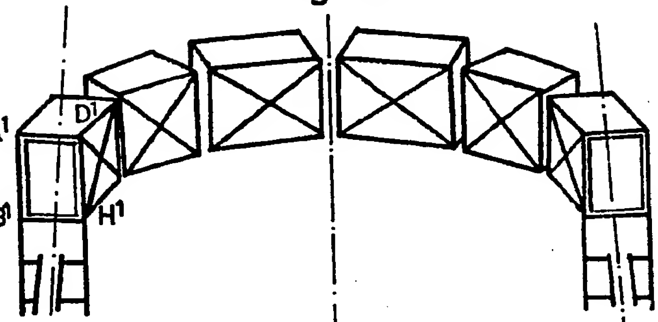


Fig. 28

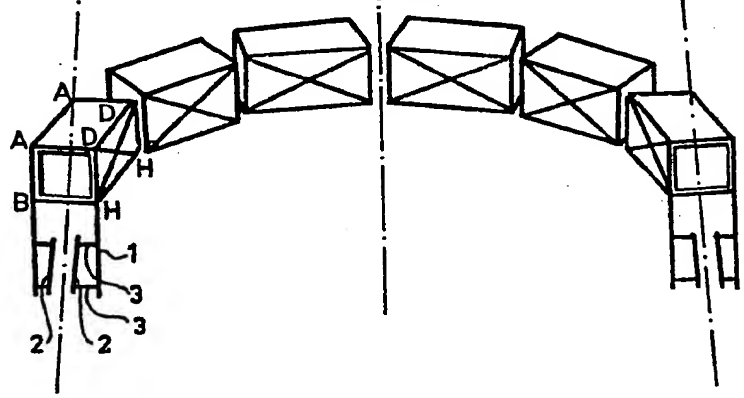


Fig. 30

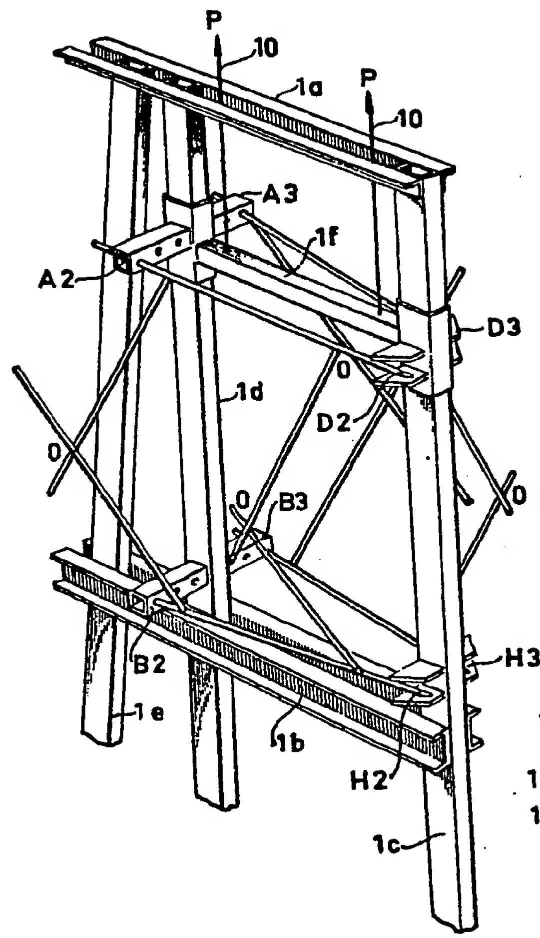


Fig. 31

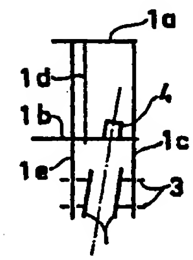


Fig. 32

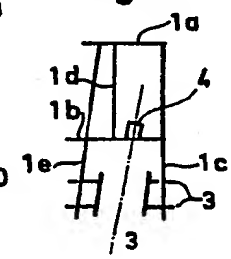


Fig. 33

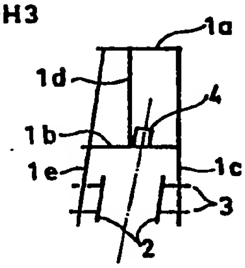


Fig.34

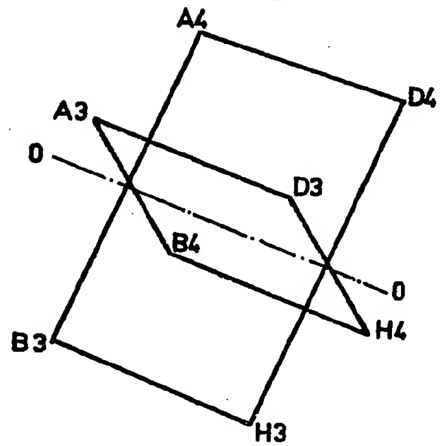
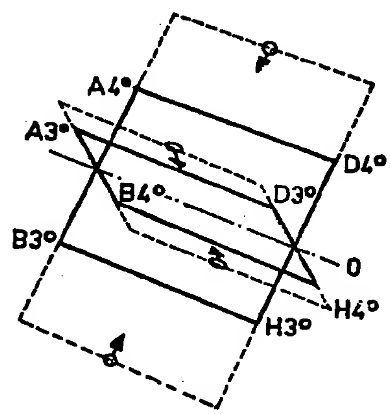


Fig.35



1218248 COMPLETE SPECIFICATION

15 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 15

Fig.36